# Cognitive science in the classroom

What does the research say?

Cognitive load is the amount of information an individual can process at any given time. This is 'working memory' - information that is being actively processed, as opposed to 'long-term memory, which is retained over time. A central component of cognitive load theory is retrieval practice. Incidentally, Rosenshine's first 'Principle of Instruction' is the recommendation that teaching an effective lesson starts with a review of previously covered material - this is 'retrieval practice' (Rosenshine 2012, p.13). Simply put, retrieval practice is the idea of regular repeated learning to gradually increase 'working memory'. Our working memory is finite - only small amounts of information can reliably be absorbed and retained at once (Sherrington 2019, p.35). Over time, as new information is introduced and external factors are taken into account, what was initially gained is largely forgotten. To use an example from my year 9 class; the students had been taught what the primary factors are in determining a country's level of development. After a few weeks, most students had forgotten most of these, as well as the named examples I provided them with, and certainly whether we categorised these as historical or geographical, or both. So how can retrieval practice be utilised to help prevent this from being a significant barrier to learning? What retrieval practice is, and how it is intended to function is shown in the graph below:
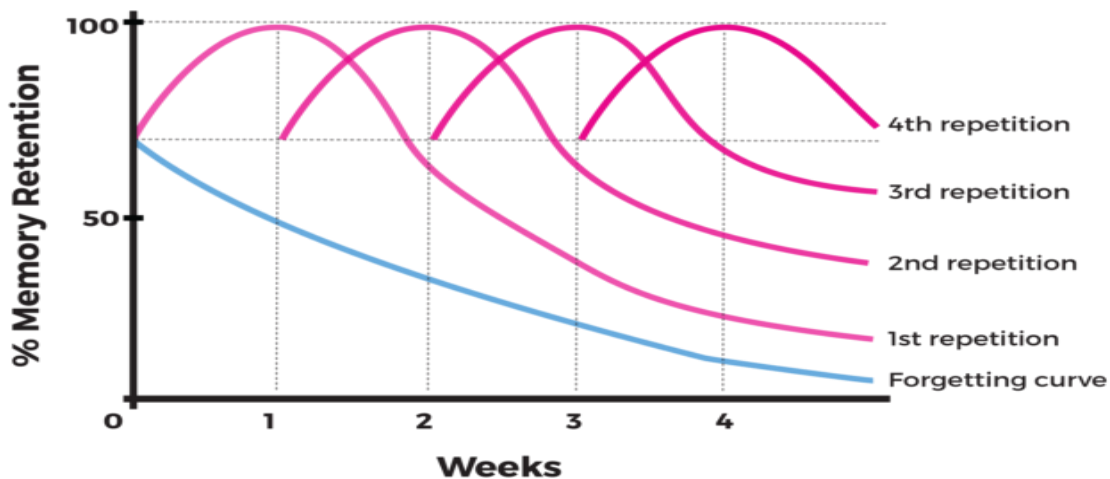
As can be seen above, an individual is not even expected to be able to retain 100% of information presented to them at the initial time of learning. After a month has elapsed, the retained information has decreased to approximately 15%, and will continue to diminish beyond that. However, once repeated learning is introduced, the average amount of information retained by the individual increases. The graph would suggest that, with every repetition, the amount can be expected to increase by 10-20%. With enough repetitions, the amount of information retained by the individual would eventually reach 100%. A great example of retrieval

practice in effect would be the learning of a foreign language; continual repetition of and immersion in would result in fluency. Indeed, in his analysis of Rosenshine's Principles, Sherrington states that enough retrieval practice will ultimately result in fluency and automaticity (Sherrington 2019, p.14).

Retrieval practice is therefore the remedy to lost *working memory.* Students are regularly and repeatedly asked similar questions or set similar tasks in order to gradually claw back what has escaped over time. This is particularly useful when previous learning is directly linked to what they are about to do. Students are far less likely to make notable progress if learning is regimented into individual lessons, with no linking or crossover between them. Retrieval practice should not solely be focused on factual recall (Coe, 2019) - it should also feature direct links to what students will be learning in the coming lesson.

An extension of retrieval practice is 'spaced learning'. Also known as 'distributed learning', conceptually this is the same as retrieval practice, except that it targets learning that was first attempted further in the past. This more accurately seeks to target *long-term memory*, by testing an individual's recall over an extended period of time. Information and prior learning are still recalled in a similar fashion, but after having allowed a much larger amount of time to have elapsed in between. In his review of Rosenshines 10 Principles of Learning, Tom Sherrington recommends that spaced learning should take place over weeks and months, if possible. (Sherrington 2019, p.37). This is enough time to allow multiple other ideas and concepts to have entered and factored into a students' cognitive load. Spaced learning can be incredibly effective when implemented correctly. I can imagine that it would work particularly well over a breadth topic, such as those often found in history curriculums, where there is plenty of information on offer over a multitude of lessons, but some that is essential - key dates, people, events and so on. However, spaced learning can be used across all subjects, and is essential, for example, in the closing stages of year 11, when the whole curriculum has been covered, and students must recall learning from months or even years prior, in order to succeed in their forthcoming exams

In summary, retrieval practice and spaced learning are both incredibly useful in maintaining and expanding a students' cognitive load, and are therefore essential practices for any classroom.As individuals progress through the education system and are introduced to an increasingly complex and detailed array of skills, concepts and practices, it is imperative that these strategies be implemented in order for them to be able to manage their cognitive load and ensure that as much learning be retained as is possible. As a result, I have introduced both retrieval practice (**LHT 2.7**) and spaced practice (**LHT 2.8**) into my own lessons; how, and with what results, is detailed below.

In practice:

The geography curriculum at the Vyne is structured in such a way that content learnt in one topic is often found in and useful for understanding those that follow (**LHT 2.2**). Essential skills such as grid references and concepts like sustainability will be present throughout Key Stages 3 and 4, should students choose to study the subject so far. Therefore, it is very important that

students regularly practise and revise these skills and concepts in order for their learning to progress. This is why retrieval practice and spaced learning are so important, and have become a key component in my lessons. I first began incorporating retrieval practice into my own lessons as soon as it was taught to me. As a geography trainee, I immediately identified the potential for this to take many different forms - whether this is straightforward questioning, image interpretation, using maps or something else entirely. Retrieval practice now features in the vast majority of lessons I teach.

LHT 2.7: I have found retrieval practice essential in teaching Year 7. I realised early on that, with the shock of secondary school yet to wear off and many still struggling to adapt to the new environment, expecting to be able to simply teach something once and expecting the class to remember it was unrealistic. It was therefore essential that I introduce retrieval practice in order for at least some knowledge to be retained, The first lesson I taught them was on 'clone towns' - we looked at what they were, what exactly made a 'clone town', and then discussed whether we though Basingstoke fell into this category. The lesson went well and most of the class could answer these questions accurately by the end of the lesson. The following lesson, questions on what a clone town was, what the features of one were, and a task of giving 5 chain and independent stores in Basingstoke were waiting for them on the board as a starter. This class has a wide range of abilities, with some students with little to no interpretive skills. The retrieval exercises I undertake with this class are therefore more straightforward than those I might attempt with my Year 8s and 9s, but the principle remains the same. It allows me to immediately assess what their working-memory has been able to absorb, as well as uncover any misconceptions that may have arisen, either through the influence of prior misconceptions, or lack of understanding (**LHT 2.6**). Additionally, I have found that the biggest benefit of retrieval practice is that students do all their recall at the beginning - once we are in the main body of the lesson, time shouldn't be wasted trying to remember what we previously covered, which, with Year 7, is a frequent occurrence. As lessons have continued, I have continued to utilise retrieval practice, chiefly as a starter, as I have found that, for Year 7s, it greatly helps prevent the loss of recall that is common at this stage of their education.

LHT 2.8: I have also benefited from implementing spaced practice into my lessons. Again, this usually takes the form of a starter task for the students to attempt when they first arrive in the class. This has been useful as classes change topics as the term progresses. Upon returning from their half-term break, Year 8 moved from human to physical geography, and vice versa for Year 9. One might predict most students in these classes, having not yet chosen their GCSE options, would be expected to quickly forget the preceding topic as they become caught up in learning a new one. However, thanks to the application of retrieval practice to their lessons, this has largely not been the case

Perhaps the best example of this can be found in my Year 8 class. The students in this class are quite enthusiastic - they enjoy and actively engage in the work I give them, and thrive off of being fed complementary facts and stories that, while not absolutely essential to their learning, are still fun and useful. In terms of **LHT 2.3**, they have strong working memory, and keenly absorb fresh information - the spaced learning I undertake with them therefore targets their

long-term memory. They are now on their second topic of the year, but really enjoyed their first, which covered megacities. As a result I have frequently incorporated spaced practice that targets key information from this topic. This means that my students can now recall key information from the megacities topic, partially because they enjoyed learning it, but mostly because spaced practice has allowed them to return previously learnt knowledge. Some particular examples of this are as follows:

- Quick questioning - e.g how many people make a megacity (10 million)
- Clues - students are given clues to particular cities: e.g. a across two continents (Istanbul)
- Matching - e.g. match the city to the image or challenge or statistic provided
- Fill the board - students are challenged to write as much as they can remember about a specific city, area, factor etc.
- Word association - places/concepts are provided and students have to share the first thing that comes to mind - hopefully this is related to what they have learnt beforehand

I introduced spaced practice as soon there was enough 'space' between the present and the first lessons I taught them. It has been a constant in all of my classes and will continue to feature heavily throughout the year, as a trustworthy way of testing and building and maintaining the long term memory necessary for continued progress (**LHT 2.5**). Additionally, I feel that my students enjoy the brief departure from their current topics - they find the testing of their broader geographical knowledge more fun and rewarding than focusing solely on one topic. This would prevent their working-memory from being overloaded - something to be avoided if consistent progress is desired

Evaluation:

In evaluation of my usage of retrieval practice and spaced learning, I would conclude that both have been essential in ensuring clear and coherent understanding amongst my students, across different classes, who studied different topics. This owes mainly to the fundamentally simple nature of both concepts - continued repetition and re-learning means that, over-time, a student's cognitive load will gradually increase.

LHT 2.7: I have found retrieval practice to be beneficial in my classes for two main reasons. Firstly, in accordance with **LHT 2.2,** it has allowed me to provide a direct and obvious link between what we have already, and what we are about to learn. By engaging in a quick summarisation of previous content, students are much better prepared for the coming lesson, and the new challenges it may present. Secondly, the versatility of retrieval practice allows me to cover a variety of skills and ideas, in a variety of ways, which means much of what I have taught can be re-visited. The variety of our current geography curriculum and the variety of ways in which I can present retrieval means almost anything I teach to any of my classes so far can be reduced down into a 5-minute exercise for later use. This is highly beneficial, as it means there is almost nothing I've taught that can't be re-taught further down the line, and students can re-learn almost anything they may have forgotten the first time around. Therefore, relatively

little, if any, of the content I have been tasked with teaching is so complex that it has to be understood on the spot.

LHT 2.8: I would argue that I have been even more successful in using spaced learning in my lessons. Students' knowledge of earlier topics has been retained due to my choosing to question them on content that may have been forgotten over time. Thanks to this, said content has passed from their working- into their long-term memory, despite a significant portion of time having elapsed. Revealingly, in their end of term assessment, covering two topics, my Year 8 class, while doing well on both, fared just as well (in some cases better) on the topic that they had completed earliest - which they had concluded almost two months prior. Of course, other factors may have contributed to this - their general interest and enjoyment of either topic (I think they liked both), or perhaps the slightly higher difficulty of their second topic (volcanoes), or even an unidentified predisposition toward human over physical geography. However, I believe that spaced practice had the biggest contribution to their success; I made sure that, while learning all about volcanoes, the megacities topic was an ever-present in our lessons. Spaced retrieval questions were a frequent feature of our lessons, and often learning was re-modelled in order for the two separate topics to be linked together - for example: why might a dormant volcano (Mt Fuji) be a hazard due to its proximity to a megacity (Tokyo)? This exemplifies, as per **LHT 2.3**, the difference between working- and long-term memory; the content of the megacity topic had successfully been committed to long-term memory, allowing space for new information. I have also benefited from not using spaced learning in sequence - rather than re-visiting previously-learnt content in the order it was taught, which has been useful in revealing which areas different students have chosen to forget.

An improvement I would like to attempt, if possible, is to move toward using retrieval practice as a plenary/end task in the closing stages of lessons. Whilst I believe I have enjoyed considerable success with retrieval as a starter task, I would also be interested how much they remember *after* a lesson of new content. Although retrieval undeniably works best as a starter activity, as per Rosenshine's first principle, it can perceivably mean that students then chose to immediately disregard the re-learned content as a new lesson and new challenges progress. Therefore I would, mainly out of personal curiosity, like to trial retrieval practice at the end of the lesson, to see what, if any, impact this might have.

Bibliography:

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Rosenshine, B. (2012) 'Principles of Instruction: Research-based Strategies that All Teachers Should Know' *American Educator* (Spring 2012), pp.12-19 ext.39

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SPECIFIC ACTION	HOW WILL YOU KNOW IT HAS IMPROVED?	WHEN BY?
Begin to implement retrieval practice as a end/plenary task to assess long-term memory after cognitive load has been filled	*Continued or improved long-term memory on a specific topic*	*March 2024*
Ensure spaced learning is covering as much of the curriculum as is possible, by focusing on a wider array of content	*Students long-term memory will have expanded to cover a greater share of content*	*March 2024*